2.2.2.3. Influence of commercial systems on private needs

As indicated above, utilities do use commercial cellular type systems (i.e., cellular, PCS or ESMR) to augment their voice systems. Commercial data systems are also employed. While these services can add to utility communications, it is highly unlikely that they will be able to serve as a replacement for the private dedicated utility system.

This study accounted for commercial system usage. As in the PSWAC study, it was assumed that approximately 10% of spectrum requirements would be satisfied by commercial systems in the future.

2.2.3. Restructuring of the Electric Utility Industry in the United States

Driven largely by industrial customers, electric utility restructuring is already unfolding in a number of states. Restructuring is often labeled "deregulation," which is a misnomer because there will still be a great deal of regulation when the smoke clears. It is perhaps better labeled "reregulation," since regulation will be redesigned and redistributed, but still pervasive.

2.2.3.1. What is Restructuring?

Restructuring is essentially the transition from "vertically integrated" monopolistic electric service to competitive service. To discuss restructuring, one must first look at how a traditional utility is structured.

Generally, there are four functional units within an electric "utility":

1. Generation;
2. Transmission;
3. Distribution;
4. The Customer Information Unit.

The generation unit converts some resource (e.g., oil, coal, nuclear fuel, air flow, water flow, etc.) into electrical energy. Electric power does not generally lend itself to efficient storage, so the amount of generation will be based upon expected demand.

The transmission unit carries the electricity that has been generated to areas where it will be utilized. Often the source of generation, a dam for example, is far removed from the end user. To effectively carry power long distances, it is necessary to use high voltage transmission lines.

The distribution side of the utility lowers the transmission voltage to practical usable voltages and delivers the electricity to the end user.

The forth category, the customer information unit, is the interface with the customer providing metering and billing for the use of the electricity.

Prior to restructuring, the above operational units usually fell within the control of a single company, i.e., the "utility." In a restructured environment however, some, if not all, of these constituent parts will be separated and operated by independent entities. Additionally, new entities may be created. For example, California has developed a system that includes an Independent System Operator (ISO). This non-profit company will be employed as an independent manager of the transmission network. It will ensure equal access to the transmission grid by all generators. A power exchange (PX) will also be employed in the California system. The PX will act as a broker for bulk power.

To get a better sense of California's restructuring plan, visit the California Energy Commission's Restructuring Web site: http://www.energy.ca.gov/restructuring. Another comprehensive Web site on restructuring is the U.S. Energy Information Administration's Restructuring site. The URL is: http://www.eia.doe.gov/cneaf/electricity/page/at_a_glance/restruct.html

2.2.3.2. How will Restructuring impact telecommunications?

Telecommunications will still be an integral part of utility operation after restructuring has taken full effect. It will still be necessary to reliably control the vast network of deployed electric networks. In fact, a greater need for wireless communications may exist due to reduced staff. As the industry becomes decentralized and power sources become increasingly dispersed, precision control systems will become critical. Additionally, automated processes and remote access will become more prevalent. These will be practicable only to the extent that communications infrastructure can support these applications.

To survive in a competitive environment, the new utility will need to keep costs to a minimum. As a result, some communications requirements will likely be outsourced. However, the utility will still require extensive private communications to support its critical infrastructure.

3. The Utilities Spectrum Assessment Taskforce (USAT) Project

3.1. Surveys

3.1.1. Steering Committee Survey

A detailed survey was developed for steering committee members to complete. After formally answering the questions on this survey, steering committee members were able to determine the shortcomings and ambiguities of the instrument. This feedback was then applied to the final survey.

3.1.2. Final Survey

The final survey was formulated using comments from those who had taken the steering committee survey. It was to be more user friendly, shorter and generally more to the point than the steering committee survey. Once completed, it was forwarded to UTC's Wireless and Frequency Coordination Sections. Additionally, it was sent to a number of additional water utilities with the help of American Water Works Association (AWWA). A total of 94 surveys were completed and returned to UTC. Charts indicating the demographics of the respondents and some highlights of the survey results follow:

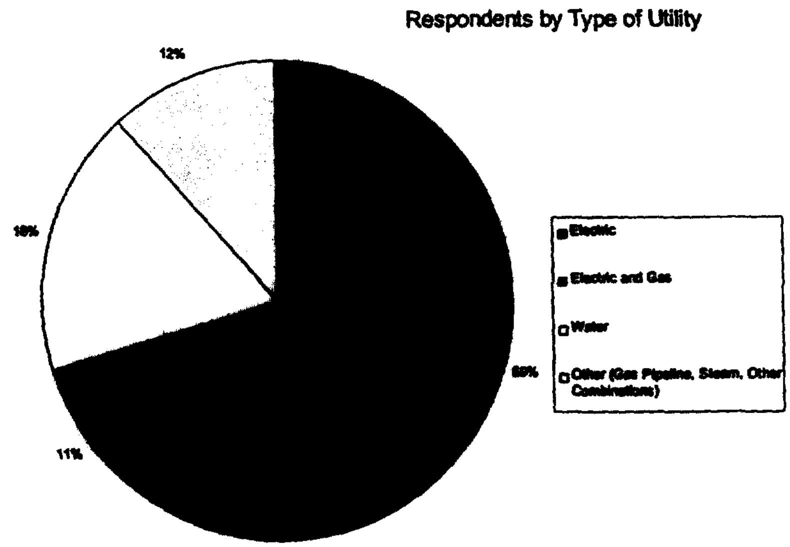


Figure 3

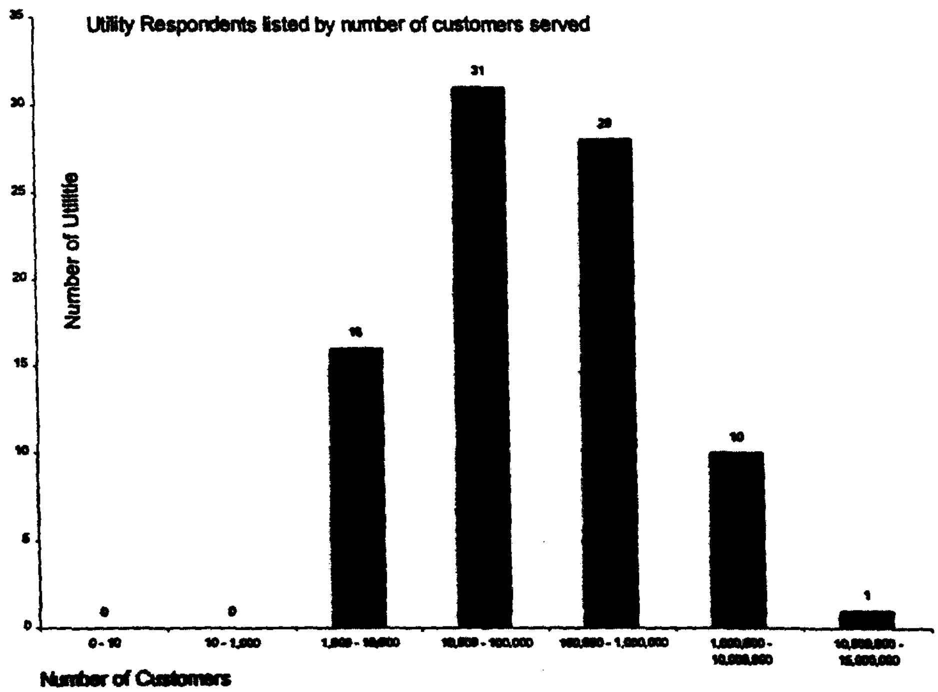
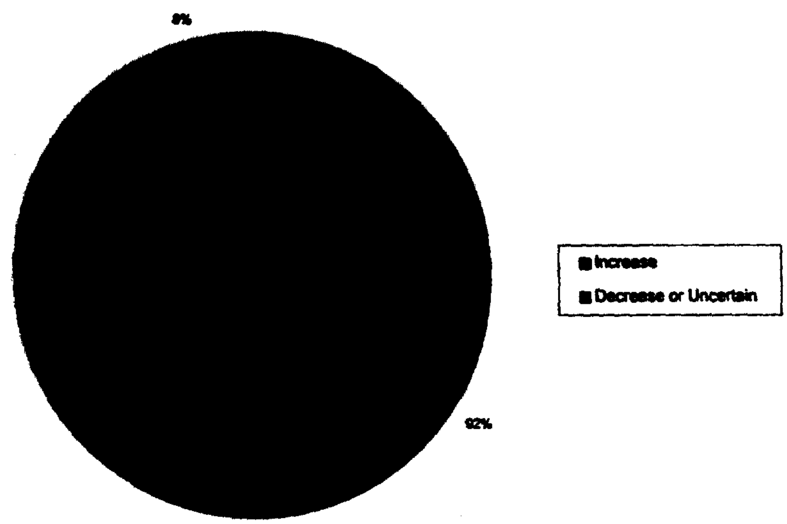


Figure 4

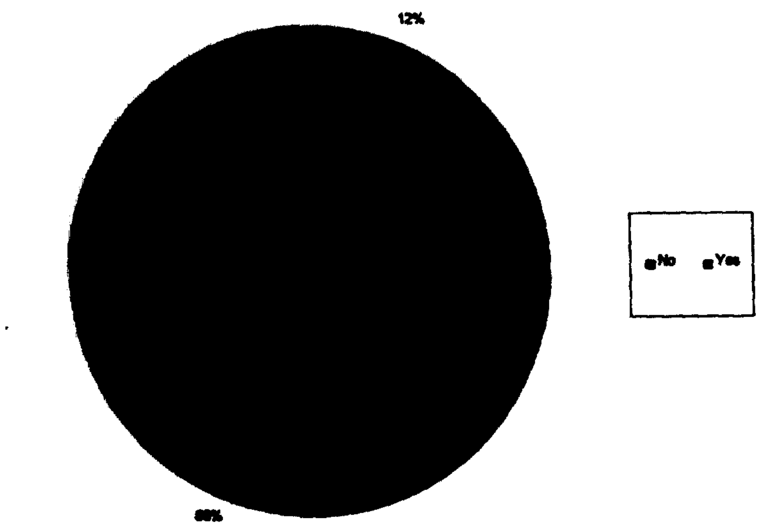
As shown above, over half of the respondents were electric utilities. Additionally, most of the respondents serve between 10,000 and 1,000,000 customers.

Figures 5 and 6 below indicate that an overwhelming majority of the respondents to the survey believe that there will be an increase in the use of wireless applications and that they will need additional spectrum to accommodate these applications.



Answers to "In general, do you foresee an overall increase or decrease in the use of privately owned, internal wireless applications (voice, data, video, etc.) in your company in the next ten years?"

Figure 5



Answers to "In the next ten years, do you anticipate needing additional spectrum to meet internal communications needs (voice, data, video, etc.)?"

Figure 6

The following figures show that there will be a considerable demand for wireless wide band data and wireless video. These technologies are gaining momentum and should be nearing maturity by the middle of the next decade.

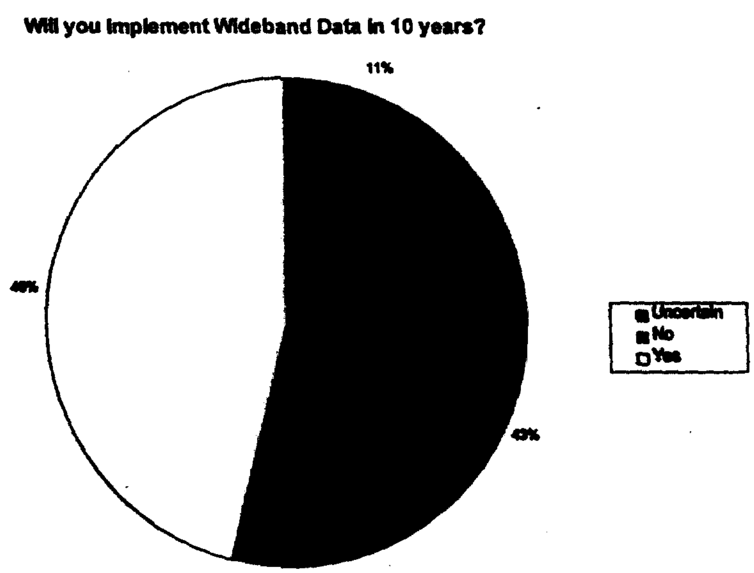


Figure 7

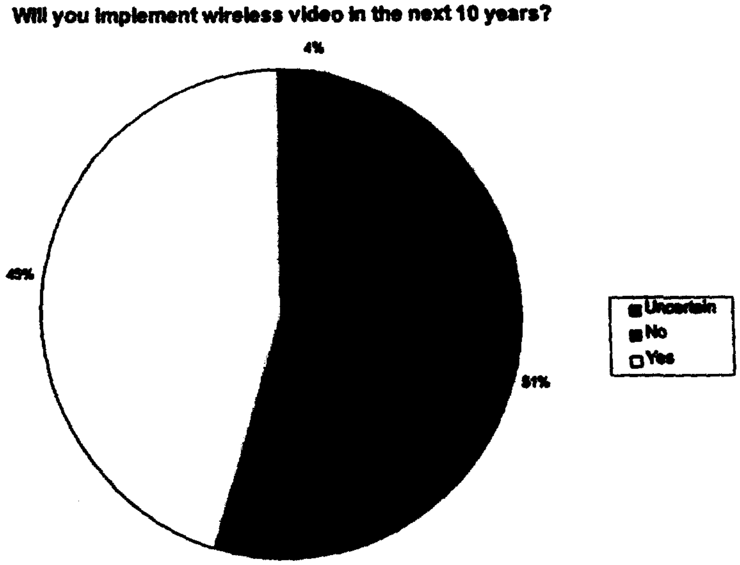


Figure 8

Figure 9 below shows that almost all of the respondents predict an increase in voice loading, and many predict a substantial increase.

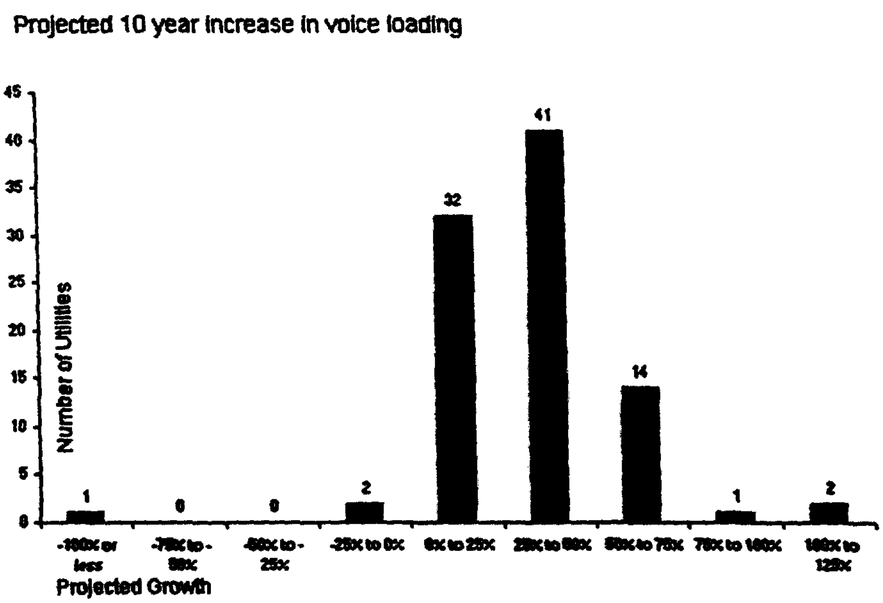


Figure 9

3.2. *Linear Projection of Spectrum Needs from Historical Data*

As further input into the process, a simple extrapolation of license demand was performed. Licensee data was taken from FCC reports and extrapolated to the year 2010. Using transmitters as the index, a 255% growth was experienced between 1984 and 1994. Extrapolating this data from 1994 to 2010, a 100% increase in the number of units is projected. While improvements in technology are likely to reduce this value, it is clear from this data that the use of wireless will likely increase and that the increase will be dramatic. The figures below show actual data points (recorded by the FCC only up until 1994) and extrapolated data based upon a linear growth factor.

Year	Linear Projection of Transmitters	Actual Number of Transmitters
1984	317444	300231
1985	364249	364728
1986	411055	415902
1987	457860	[illegible]
1988	504666	524366
1989	551471	557270
1990	598276	574873
1991	645082	665740
1992	691887	706490
1993	738693	731389
1994	785498	768551
1995	832303	
1996	879109	
1997	925914	
1998	972720	
1999	1019525	
2000	1066330	
2001	1113136	
2002	1159941	
2003	1206747	
2004	1253552	
2005	1300357	
2006	1347163	
2007	1393968	
2008	1440774	
2009	1487579	
2010	1534385	

Figure 10

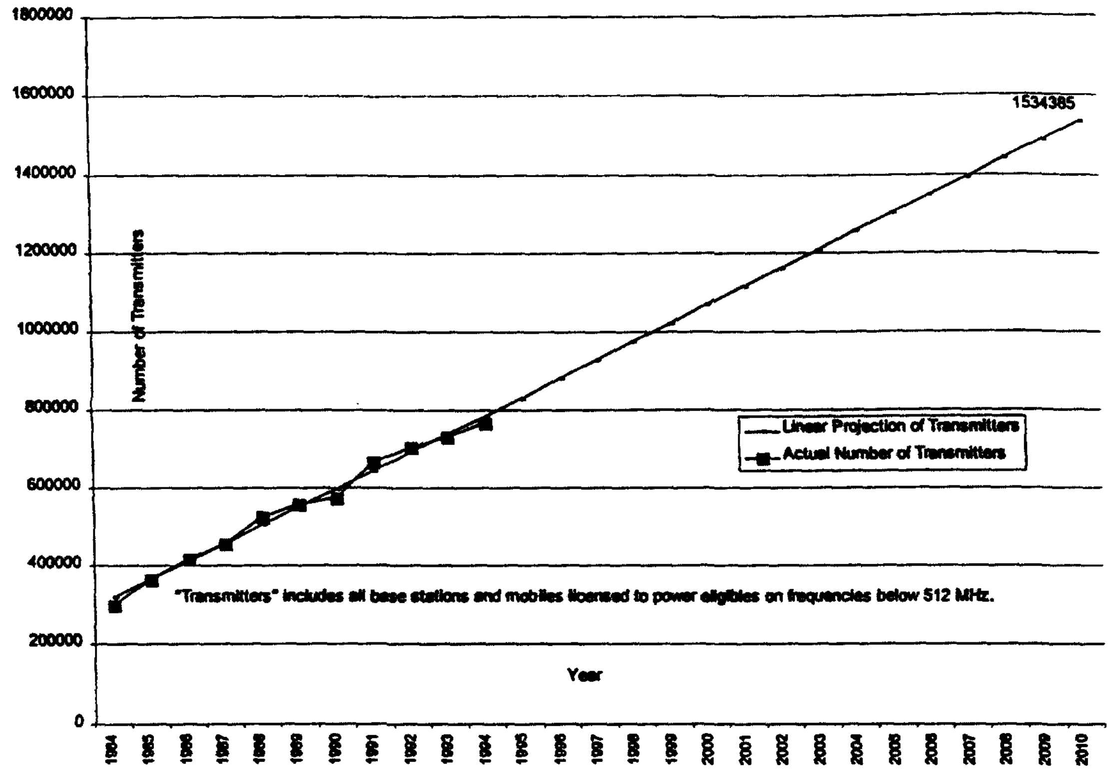


Figure 11

3.3. *Empirical Model: Los Angeles County*

The USAT task force decided that a specific urban area should be examined to determine the final spectrum requirement. Los Angeles County was chosen primarily because of its size and density of users.

The total number of utility employees for the county was obtained from United States Census data. From USAT survey data and previous market studies, a 66% voice radio penetration rate was applied to the employee count. Then, a 4% annual growth rate in voice radio usage was applied. As in the PSWAC study, wide band data and video projections were indexed on voice usage. From the USAT survey, it was determined that utility users would fall into the "heavy" usage category of both wideband data and video. This produced values of 27.33% of voice penetration for wide band data and 17% of voice penetration for video. Because these technologies are not yet mature, the penetration values were scaled back in the projection for the year 2000.

The amount of "current" spectrum available to utilities was subtracted from the "projected" spectrum requirements. The value for the current spectrum was calculated to be 2.24 MHz. The methodology for this calculation is included in Appendix A.

The spectrum projections were broken into three benchmark dates: 2000, 2004, and 2010. The projected spectrum requirements, less current power spectrum, are listed in the table below:

Year	2000	2004	2010
Bandwidth Required	1.0 MHz	1.9 MHz	6.3 MHz

The complete results of the Los Angeles projection are attached in Appendix B.

4. Conclusion

Utilities rely heavily on the use of private wireless systems for voice and data applications. The need for private wireless spectrum available to utility users will only increase as we transition from the twentieth to the twenty-first century. A total of 6.3 additional MHz will be needed by the year 2010. In addition to increased voice requirements, two other applications will increase the need for spectrum: wideband data and wireless video. These two developing technologies will play an increasingly important role in the operations of today's utility and the utility of the twenty-first century.

Appendix A: Methodology and Definitions

General Definitions

The formula used to calculate bandwidth was the PSWAC study equation, that is:

$$\text{Required Bandwidth (MHz)} = \frac{\text{Erlangs Per Unit X No. of Units X SRC X 10}}{\text{COD X Rate X Load X Reuse X (100-Error)}}$$

where:

Erlangs Per Unit: A measure of traffic load, or the time that the user transmits on a channel, expressed as a ratio between 0.0 and 1.0. With 1.0 erlang the user transmits all the time and with 0.0 erlang the user never transmits. The Erlangs Per Unit is that factor averaged over all of the transmitters being considered.

No. of Units: The number of transmitters within the geographic area being considered that are in service over the time under consideration.

SRC (Kbps): The content of the source message to be transmitted is represented by the shortened form SRC. All messages are in digital format, and the units are kbps, (kilo-bits-per-second).

COD: This is a dimensionless factor of improvement in coding of the message into bits to be transmitted. This improvement will take place between now and the date for which the computation is made.

Rate (b/s/Hz): The rate at which data bits are transmitted over the air by the transmitter in each Hz of its RF channel bandwidth. The units are b/s/Hz, (bits-per-second-per-Hz).

Load (%): The average percent of time that the channels are occupied by a transmission from a user.

Reuse: The number of times the same RF channel is reused within the geographic area under consideration.

Error (%): The average amount of error coding and overhead that is applied to the digitally formatted message before transmission. With 0% coding there are no bits added to the message, and with 50% coding, half of the transmitted bits will be dedicated to overhead, error mitigation and correction.

Current Spectrum Allocated to Power (IW) Users

The primary focus of this report was on Part 90 "mobile" spectrum. Consequently, the "current spectrum allocated to power users" was based entirely on channels allocated in Part 90. This assessment did not consider Part 101 "fixed" microwave spectrum.

To best gauge the amount of "IW" (power) spectrum, pre-refarming channels were analyzed. In the VHF/UHF bands, the bandwidths of the exclusive IW channels were added together to yield 0.565 MHz of spectrum.

800/900 MHz spectrum proved more difficult to evaluate because utilities do not have their own "pool" within the 800/900 MHz band, but rather are part of the more general Industrial/Land Transportation pool. To determine the amount of "utility" spectrum in this band, a 35-mile radius search was performed about the center of the City of Los Angeles for all Industrial/Land Transportation entities in the 800 and 900 MHz bands. These records were then analyzed to determine which licensees were utilities. After separating the utilities from the non-utilities and accounting for duplicate records, 1.68MHz of 800/900MHz utility spectrum was calculated.

Adding the VHF/UHF spectrum (0.565 MHz) to the 800/900 MHz spectrum (1.68 MHz) yielded the total current mobile spectrum available to utilities: 2.24 MHz.

Improved Future Technology

Future improvements in technology were addressed by the USAT model. As digital modulation and coding schemes become more sophisticated, wireless communication systems will be able to deliver more capacity per unit of electromagnetic spectrum (Hz). These improvements were addressed by the "rate" and "err" parameters in the model.

"Rate" is expressed in the units of b/s/Hz (bits-per-second-per-Hz), and is defined as the rate at which data bits are transmitted over the air by the transmitter in each Hz of its RF channel bandwidth. Clearly, as systems become more efficient, the rate will increase. Thus, there will be more bits-per-second for the same 1 Hz of bandwidth. Today, for example, a typical digital radio operating on 12.5 kHz channel, operates at a throughput of 9.6 kbps (e.g., 4.8 kbps VSELP added to 2.1 kbps Error Correction Coding and 2.7 kbps Embedded Signaling). 9.6 kbps divided by 12.5 kHz yields 0.768 kbps/kHz. This reduces to 0.768 bps/Hz. In the USAT model, the rate values .75 for voice and data and 2 for wideband data and video were employed for the year 2000. By 2010 these values increase to 1/1.5 and 3.5 respectively. The "err," or "error," parameter is defined as the average amount of error coding and overhead that is applied to the digitally formatted message before transmission. With 0% coding there are no bits added to the message, and with 50% coding, half of the transmitted bits will be dedicated to overhead, error mitigation and correction. This parameter will probably improve in future years. "Improvement" will yield a smaller value -- less coding with greater throughput. In the USAT model, the err factor was set at 54% for the year 2000 and improved to 50% by the year 2010.

Appendix B: Spectrum Calculation Worksheet

UTILITIES SPECTRUM REQUIREMENTS, 1996-2010.
R.E. RUTHENBERG

TABLE 1

Vertical Market	1996 Total Employees- LA County	1996 Total Employees- U.S.	Radio Penetration %	1996 Total LA County Radios	1996 Total U.S. Radios
UTILITIES ONLY	18918	757000	66%	12486	499620

NOTE: The transceiver count for LA utilities is calculated by assuming the penetration (66%) is the same as for the penetration of the total of (utilities + telephone markets) in the county.

TABLE 2

L.A. COUNTY RADIO USE FORECAST

MARKET	1996 TOTAL EMPLOYEE	1996 TOTAL RADIOS	PENETRATIO %	CURRENT SVCS GROWTH RATE %	2000 TOTAL RADIOS	2010 TOTAL RADIOS	TYPE USER H/M/L	ADV SVCS PENETRATION (% OF VOICE RADIO USERS) W.B. DATA %	VIDEO %	ADV SVCS # RADIO UNITS 2000 TOTAL W.B. DATA	2000 TOTAL VIDEO	2010 TOTAL W.B. DATA	2010 TOTA VIDEO
UTILITIES	18918	12486	66.0	4	14049	20797	H	27.33	17	384	239	5684	3535

NOTES
(1)THE 1996-2000 GROWTH RATE IS ASSUMED TO BE APPROXIMATELY [illegible] OF LONG TERM TO ACCOUNT FOR ASSUMED MARKET "CHILLING" DUE TO VARIOUS FACTORS INCLUDING USER UNCERTAINTY RELATIVE TO "REFARMING" FCC RESOLUTIONS, LICENSING FREEZES AND AUCTION ISSUES AT [illegible], COORDINATION POOL CONSOLIDATION RESOLUTIONS, DEVELOPMENT OF NEW COORDINATOR SOFTWARE AND INTER-COORDINATOR NETWORKS, ETC.
(2)YEAR 2000 WB SERVICE PENETRATION IS ASSUMED AT 0.1 THAT OF YEAR 2010.

TABLE 3
SPECTRUM REQUIREMENTS CALCULATION
YEAR 2000

	ERLANGS/ UNIT	# UNITS	SRC KBPS	COD	RATE B/S/HZ	LOAD %	REUSE	ERR %	SPECTRUM MHZ	EFF. CHANNEL BW - KHZ
VOICE	0.0242	14049	6	1	0.75	54.5	4	54	2.71	17.4
DATA	0.00435	7025	6	1	0.75	54.5	4	54	0.24	17.4
STAT/MESSAGE	0.0004	7025	6	1	0.75	54.5	4	54	0.02	17.4
W.B. DATA	0.007	384	384	2	2	54.5	4	54	0.26	208.7
VIDEO	0.012	239	384	2	2	54.5	4	54	0.27	208.7
								SUB TOTAL	3.51	
							LESS	COMM SVCS	-0.30	
								TOTAL REQD	3.2	
							LESS	EXISTING	2.24	
								FINAL TOTAL	1.0	

NOTES
(1) THE ABOVE FACTORS ARE ESTIMATED FOR YEAR 2000, AND DEMONSTRATE LESS TECHNOLOGY IMPROVEMENT THAN FOR YEAR 2010, OBVIOUSLY THE CASE.
(2) DATA AND STATUS MESSAGE ARE ESTIMATED AT A PENETRATION OF HALF VOICE.
(3) REUSE FACTOR FOR CURRENT SERVICES IS HIGHER THAN YEAR 2010 AND REPRESENTS THE MORE CROWDED, REDUCED COMMUNICATIONS QUALITY OF TODAYS PLMR SERVICE.

TABLE 4

SPECTRUM REQUIREMENTS CALCULATION

YEAR 2004

	ERLANGS/ UNIT	# UNITS	SRC KBPS	COD	RATE B/S/HZ	LOAD %	REUSE	ERR %	SPECTRUM MHZ	EFF. CHANNEL BW - KHZ
VOICE	0.088144	15508	6	1	0.8	54.5	4	54	3.03	16.3
DATA	0.007982	7754	6	1	0.8	54.5	4	54	0.44	16.3
STAT/MESSAGE	0.0004	7754	6	1	0.8	54.5	4	54	0.02	16.3
W.B. DATA	0.0126	424	384	2	2.2	54.5	4	54	0.46	189.7
VIDEO	0.0216	264	384	2	2.2	54.5	4	54	0.50	189.7
								SUB TOTAL	4.46	
NOTES							LESS	COMM SVCS	-0.35	
								TOTAL REQD	4.1	
							LESS	EXISTING	2.24	
								FINAL TOTAL	1.9	

(1) THE ABOVE FACTORS ARE ESTIMATED FOR YEAR 2000, AND DEMONSTRATE LESS TECHNOLOGY IMPROVEMENT THAN FOR YEAR 2010, OBVIOUSLY THE CASE.

(2) DATA AND STATUS MESSAGE ARE ESTIMATED AT A PENETRATION OF HALF VOICE.

(3) REUSE FACTOR FOR CURRENT SERVICES IS HIGHER THAN YEAR 2010 AND REPRESENTS THE MORE CROWDED, REDUCED COMMUNICATIONS QUALITY OF TODAYS PLMR SERVICE.

TABLE 5

SPECTRUM REQUIREMENTS CALCULATION

YEAR 2010

	ERLANGS/ UNIT	# UNITS	SRC KBPS	COD	RATE B/S/HZ	LOAD %	REUSE	ERR %	SPECTRUM MHZ	EFF. CHANNEL BW - KHZ
VOICE	0.035	20797	6	1.25	1	54.5	3.5	80	3.86	9.60
DATA	0.0067	[illegible]	6	1	1.5	54.5	3.5	80	0.28	8.0
STAT/MESSAGE	0.0004	[illegible]	6	1	1.5	54.5	3.5	80	0.02	8.0
W.B. DATA	0.014	6884	384	3	3.5	54.5	4	80	2.67	73.1
VIDEO	0.024	3535	384	3	3.5	54.5	4	80	2.85	73.1
								SUB TOTAL	9.58	
NOTES							LESS	COMM SVCS	-1.08	
								TOTAL REQD	8.5	
							LESS	EXISTING	2.24	
								FINAL TOTAL	6.3	

(1) ESTIMATES UTILIZE PSWAC TECHNOLOGY FACTORS, MODIFIED FOR NON-PS CONDITIONS.

(2) DATA AND STATUS MESSAGE ARE ESTIMATED AT A PENETRATION OF HALF VOICE.

(3) REUSE FACTOR FOR CURRENT SERVICES ARE ASSUMED SLIGHTLY HIGHER THAN PSWAC DUE TO TO ASSUMED MORE CROWDED CONDITIONS THAN P.S., YET LOWER THAN YEAR 2000 BASED ON ASSUMPTIONS OF BOTH IMPROVED COMMUNICATIONS QUALITY YET LESS REUSE DUE TO INTERFERENCE BETWEEN NARROW CHANNELS.

TABLE 6

ADDITIONAL SPECTRUM REQUIREMENT SUMMARY

	--------- REQUIREM ---------						
YEAR	NB VOICE/ DATA - MHZ	WB DATA MHZ	VIDEO MHZ	TOTAL REQD MHZ	CURRENT SPECTRUM	TOTAL ADDTL REQUIRED SPECTRUM (MHZ)	ADDTL REQMNT , % of LMCC TOTAL
1995	2.24			2.24	2.24	0.00	
2000	2.68	0.26	0.27	3.21	2.24	0.97	6.5
2004	3.15	0.46	0.50	4.11	2.24	1.87	4.2
2010	3.25	2.40	2.85	8.50	2.24	6.26	5.0

Note: For calculation purposes, the "Required spectrum" for year 1995 is assumed to be zero, even though that is not necessarily true i.e. the service was (and still is) more than likely already heavilly congested.

DEFINITION: Utilities, as used herein:

90.63 (a) (Power Radio Service) describes "Power" entities as those engaged in (1) The generation, transmission or distribution of electrical energy for use by the general public or by the members of a cooperative; (2) The distribution of manufactured or natural gas by means of pipe line, for use by the general public or by the members of a cooperative organization, or, in a combination of that activity with the production, transmission or storage of manufactured or natural gas preparatory to such distribution; (3) The distribution of steam by means of pipeline or, of water by means of pipeline, canal, or open ditch, for use by the general public or by the members of a cooperative organization, or in a combination of that activity with the collection, transmission, storage, or purification of water or the generation of steam preparatory to such distribution; or (4) The providing of a supporting service by a corporation directly related to activities of its parent corporation...

Appendix C: USAT Steering Committee

First Name	Last Name	Affiliation
Klaus	Bender	Itron
Jerry	Briggs	Texas Utilities
Jeff	Cohen	Wilkinson, Barker, Knauer & Quinn/Cellnet
Allen	Davidson	Motorola
Tom	Goode	UTC
Carl	Greenway	Kansas City Power & Light Company
Dennis	Guard	UTC
Ralph	Haller	Fox Ridge Communications
John	Howell	Houston Lighting & Power Company
Al	Ittner	Motorola
Dick	Krause	Southern California Edison
John	Krupcale	Niagara Mohawk Power Corporation
Ed	Leisten	Motorola
John	Ng	Potomac Electric Power Company
Jerry	Obrist	Lincoln Water System
John	Ratliff	Cellnet
Ross	Ruthenberg	Motorola
Gary	Schwartz	Rappahannock Electric Cooperative
Jeff	Sheldon	UTC
Robert	Speidel	Ericsson
Pat	Spilman	Basin Telecommunications
Sean	Stokes	UTC
George	Stoll	Utilities Telecommunications Consulting Group
Karnel	Thomas	UTC
Al	Vazquez	Southern California Edison
Steve	Via	American Water Works
Dick	Weber	Basin Telecommunications
Tom	Whaley	Motorola
Brian	Wolf	Basin Telecommunications